January 2009

# Evaluation of dentoalveolar compensation in skeletal class II malocclusion in a Pakistani University Hospital setting

Nabila Anwar
*Aga Khan University*

Mubassar Fida
*Aga Khan University*

ORIGINAL ARTICLE

# Evaluation of Dentoalveolar Compensation in Skeletal Class II Malocclusion in a Pakistani University Hospital Setting

Nabila Anwar and Mubassar Fida

## ABSTRACT

**Objective**: To quantitatively evaluate the pattern of dentoalveolar compensation in skeletal class II patients and to find which dentoalveolar parameter compensates the most for this sagittal jaw discrepancy.

**Study Design**: Cross-sectional study.

**Place and Duration of Study**: Dental Section, the Aga Khan University Hospital, Karachi, from January 2005 to March 2006.

**Methodology:** Cephalometric analyses were performed on pretreatment lateral cephalographs of 87 orthodontic patients who met the selection criteria. Various linear and angular measurements were taken. For a quantitative evaluation of dentoalveolar compensation, association was found between various dental and skeletal parameters by correlation analyses. To evaluate which parameter compensates the most, regression and scatters were performed keeping ANB angle as a measure of sagittal jaw discrepancy versus some parameters (SN-OP, A-NP, UI-NA, IIA, LI-OP, LI-SN, LI-FH, LI-MP).

**Results**: Statistically significant associations were seen between some skeletal and dental parameters. Correlation and regression analyses indicated SN-OP, LI-OP and LI-FH to be the most likely parameters to compensate for underlying sagittal jaw discrepancies.

**Conclusion**: Lower incisor position and occlusal plane inclination in relation to the craniofacial structures are the most likely parameters for compensation in class II sagittal jaw discrepancy, evaluation of which may be helpful in treatment planning and treatment success.

**Key words:** *Dental compensation. Skeletal class II. Incisor angulation. Occlusal plane.*

## INTRODUCTION

Malocclusion, 'a perversion of the normal growth and development' can be skeletal or dental in origin.[1] Various angular and linear measurements have been incorporated in various cephalometric analyses for characterization of patient's craniofacial skeleton to help clinicians in diagnosing the amount of skeletal and dental discrepancies contributing towards the presenting malocclusions and also to diagnose the limitations of tooth movement in a particular case so that an appropriate and stable treatment plan is chosen for the patient.[2,3] In this regard, a clinician must not ignore an important natural phenomenon i.e. dentoalveolar compensation, 'a system which attempts to maintain normal interarch relationship under varying jaw relationships.[4,5] This balancing or compensatory property also exists within the dentoalveolar complex to preserve the overall harmony and proportions of the dentofacial components.[6] Where there is imperfect coordination in development of the upper and lower jaws or dentoalveolar complex, a malocclusion will result.[7,8]

*Section of Dentistry, Department of Surgery, The Aga Khan University Hospital, Karachi.*

***Correspondence:*** *Dr. Nabila Anwar, Room No. 217, Women's Residences, The Aga Khan University Hospital, Stadium Road, Karachi.*
*E-mail: nabila.anwar@aku.edu*

*Received November 22, 2007; accepted November 28, 2008.*

Compensations can be dental or skeletal in nature. Dental compensations can be vertically in basal and dentoalveolar heights, transversely in arch dimensions and/or sagittaly in tooth inclinations, particularly of incisors. The factors responsible for dentoalveolar adaptation include: a normal eruptive system, surrounding soft tissue pressures and the influence by the neighbouring and opposing teeth during occlusion.[4] When the dentoalveolar compensatory mechanism is taken into account the cephalometric analysis has two parts. The jaw relationship is assessed and secondly the extent of compensation is examined. The treatment objectives then depend on whether tooth movement, growth modification or surgical repositioning of the jaws is to be used. In an approach based mainly on tooth movements, the treatment objectives are the necessary compensatory adjustments in tooth position relative to their basal bone. In treatments utilizing repositioning of jaws by growth or surgery, the aim is to eliminate some degree of dentoalveolar compensation in an attempt to treat the underlying skeletal discrepancy.[4]

When tooth movements are aimed, attention has to be given to the upper and lower incisors which are guided towards one another to establish an occlusion.[9-11] The importance of the knowledge of the amount of dentoalveolar compensation already occurring in the patient is crucial because of limited alveolar housing of incisors which may limit mechanics towards a range of normality, which is also a range of stability and of optimal facial aesthetics. This study was aimed at evaluating the pattern of dentoalveolar compensation in skeletal class II patients presenting to the orthodontic clinic and also to find which dentoalveolar parameter compensates the most frequently for this sagittal jaw discrepancy.

## METHODOLOGY

The present cross-sectional study was carried out on pre-treatment lateral cephalographs of orthodontic patients who visited the Orthodontic Clinic from January 2005 to March 2006. Patients with full complement of teeth (excluding 3rd molars), age between 12 and 22 years and having skeletal class I or class II patterns were included in the study. Those having facial asymmetries, excessive vertical dysplasias, previous orthodontic treatment and craniofacial disorders were excluded. Cephalographs were traced manually by the author according to the conventional method. The cephalometric landmarks and planes used in the study are shown in Figure 1.

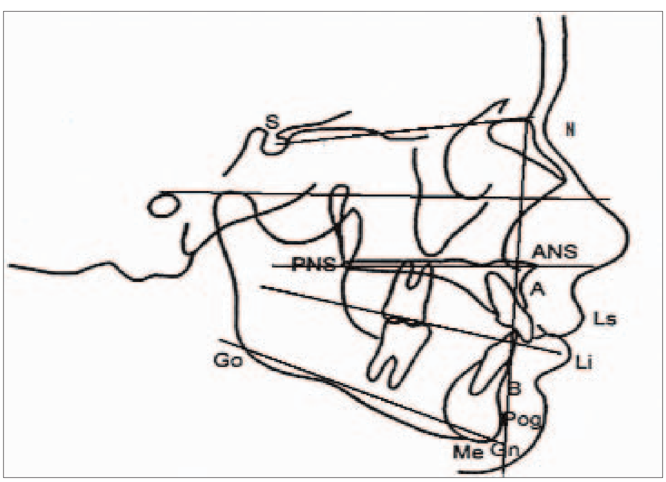


**Figure 1:** Cephalometric landmarks and planes.

Cephalometric analysis was based on the parameters shown in Table I. Angle ANB was used to classify jaw patterns as skeletal class I (ANB=0 to $4^{o}$) or skeletal class II (ANB= > $4^{o}$).[12] Fifteen angular and five linear measurements were taken to assess the skeletal pattern and the amount of dentoalveolar compensation. To determine tracing and measurement errors, 10 randomly selected lateral cephalographs were retraced and remeasured by the author at 3 weeks interval.

Descriptive statistics were used to identify means for each parameter and independent sample t-test was used to compare the means in both skeletal classes. To evaluate dental compensation quantitatively, correlation analyses was performed to find association between skeletal (SNA, SNB, ANB, FA, AO-BO, A-NP, Pog-NP, SN-PP, SN-MP, SN-OP and Y-axis) and dental parameters (UI-NA (mm), UI-SN, IIA, LI-NB (mm), LI-FH, LI-MP, LI-OP, LI-SN). To evaluate which parameter compensates the most, regression lines and scatter diagrams were obtained keeping ANB angle as a measure of sagittal jaw discrepancy versus some of the parameters used in this study (SN-OP, A-NP, NA, IIA, LI-OP, LI-SN, LI-FH, and LI-MP). Wilcoxon sign rank test was used for assessment of intra-examiner reliability. Statistical analyses were performed with SPSS 14.0 software for Windows.

**Table I**: Cephalometric angular and linear measurements.[12-16]

- SNA angle (SNA): inward angle toward the cranium between the NA line and the sella-nasion (SN) plane.
- SNB angle (SNB): inward angle toward the cranium between the NB line and the SN plane.
- ANB angle (ANB): angle between the NA and NB lines, obtained by subtracting SNB from SNA.
- AO-BO distance (Witts). Distance from AO point to BO point.
- SN plane to mandibular plane angle (SN-MP): angle between the SN plane and the mandibular plane (MP).
- A point to nasion perpendicular (A-NP): distance between A point and N perpendicular line measured perpendicular to N perpendicular line.
- Pogonion to N perpendicular (Pog -NP): distance between pogonion and N perpendicular line measured from the perpendicular to N perpendicular line.
- IIA (interincisal angle): angle is measured between the extension of the maxillary and mandibular incisor long axis line; the most posterior angle is measured.
- Maxillary incisor to SN plane (U1-SN): most inferior inward angle formed by the extension of the long axis of the maxillary incisor to the SN plane.
- Maxillary incisor to NA plane (U1-NA): distance between the tip of the upper incisor and a line from N to point A.
- Mandibular incisor to NB (L1-NB): distance between the tip of the mandibular incisor and a line from nasion to point B.
- Mandibular incisor to mandibular plane (LI-MP): long axis of the mandibular incisor is measured to the mandibular plane; the most inward angle toward the body of the mandible is measured.
- Sella Nasion Plane to Palatal Plane (SN-PP): angle between SN Plane and Palatal Plane.
- Sella Nasion to Occlusal Plane angle (SN-OP): angle between SN Plane and Occlusal Plane.
- Lower Incisor to Sella Nasion angle (LI-SN): angle between mandibular incisor long axis line and SN Plane.
- Lower Incisor to Occlusal Plane angle (LI-OP): angle between mandibular incisor long axis line and Occlusal Plane.
- Lower Incisor to FH Plane angle (LI-FH): angle between mandibular incisor long axis line and FH Plane.
- Y axis: acute angle formed between Sella Gnathion line and FH Plane.

## RESULTS

The total number of patients in the study was 87 (32 males and 55 females). The mean age was 15 years and 11 months ranging from 11-22 years. Forty patients belonged to skeletal class I (46%) and 47 were skeletal class II (54%). Table II shows the comparison of means for various variables and the results of independent sample t-test in both skeletal classes. Significant differences were found between the means of various skeletal variables. Amongst the dentoalveolar parameters, only the lower incisor inclination showed significant differences between skeletal class I and class II.

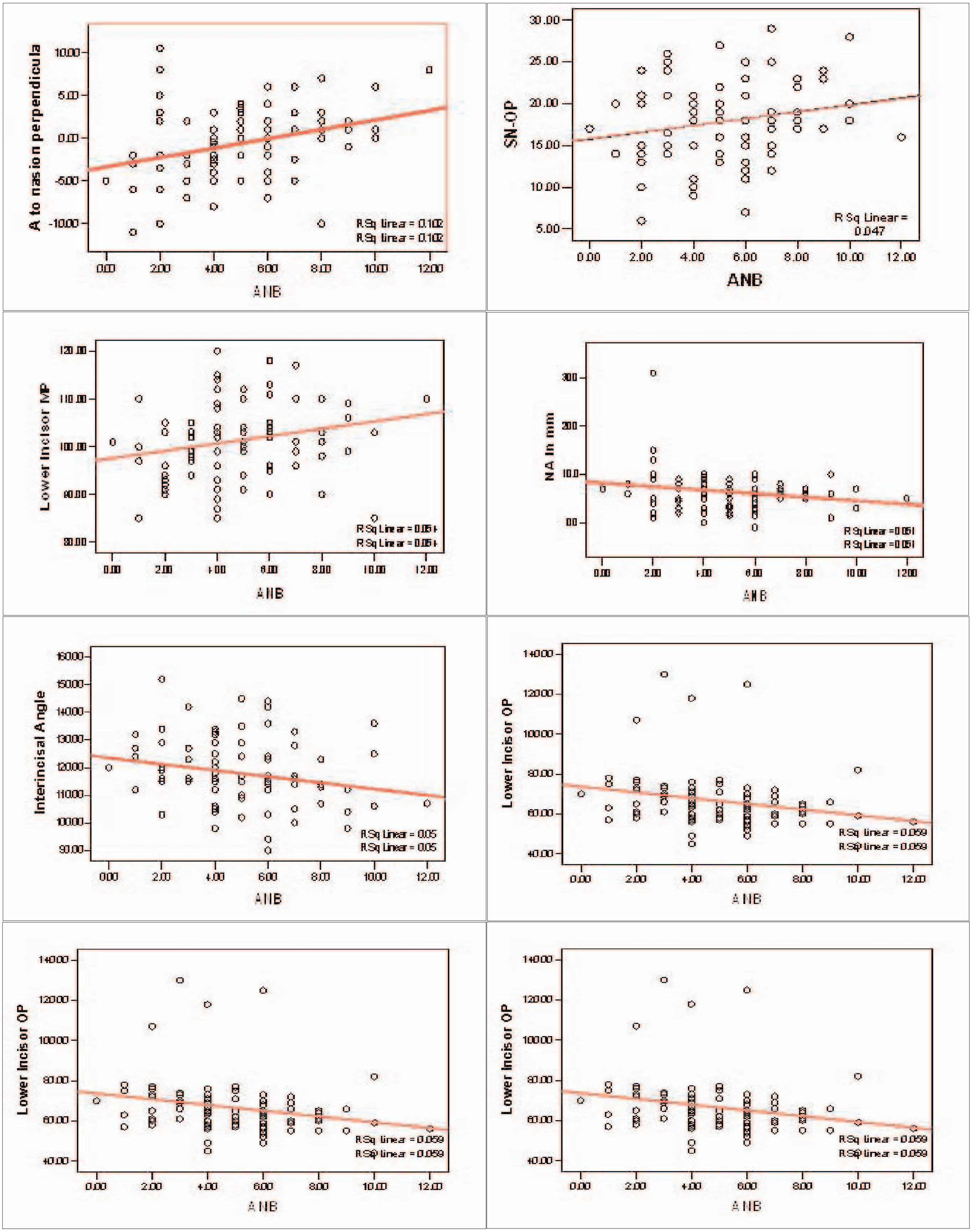


**Figure 2:** scatter diagrams and regression lines of ANB vs. dentoalveolar parameters..

**Table II**: Comparison of means in skeletal class I and class II.

| Parameter | Skeletal class I n=40 | Skeletal class II n=47 | p-value |
|---|---|---|---|
| SNA | 80.60 | 81.78 | 0.09 |
| SNB | 77.57 | 75.72 | 0.14 |
| ANB | 3.05 | 6.63 | 0.11 |
| FA | 85.17 | 84.36 | 0.43 |
| A-NP | -1.61 | 0.22 | 0.42 |
| POG-NP | -6.51 | -9.37 | 0.72 |
| AO-BO | 0.13 | 2.67 | 0.19 |
| SN-MP | 34.60 | 32.10 | 0.82 |
| SN-PP | 8.20 | 7.94 | 0.06 |
| LI-OP | 70.27 | 63.29 | 0.27 |
| LI-FH | 55.95 | 51.51 | 0.17 |
| LI-NB | 28.60 | 31.55 | 0.22 |
| LI-MP | 98.92 | 103.55 | 0.78 |
| LI-SN | 47.35 | 43.80 | 0.09 |
| IIA | 121.12 | 115.12 | 0.86 |
| UI-NA | 6.95 | 5.91 | 0.34 |
| UI-SN | 107.52 | 108.61 | 0.43 |
| Y- axis | 62.27 | 63.25 | 0.07 |
| LI-NB | 28.60 | 31.55 | 0.22 |
| SN-OP | 17.36 | 18.19 | 0.57 |

*N=87, test of significance: t-test, p-value ≤ 0.05*

Table III shows the correlation coefficients between various dental and skeletal variables. For the relationship of incisor inclination to jaw discrepancy, lower incisor measurements were significantly correlated with various skeletal measurements but correlation coefficients varied considerably. The highest correlation coefficient (0.490) was found between LI-FH angle and FA followed by coefficient between LI-MP and AO-BO (0.353). Occlusal plane inclination also showed some significant associations; the highest being between SN-OP and SNB (-0.586) followed by between SN-OP and FA (-0.400). Intra-examiner reliability was confirmed by statistically insignificant differences ($p > 0.05$) between the first and the second group of cephalometric measurements.

**Table III**: Correlation analysis between dental and skeletal parameters.

| | SNA | SNB | IIA | NA mm | NB mm | UI-SN | LI-SN | LI-OP | LI-MP | LI-FH |
|---|---|---|---|---|---|---|---|---|---|---|
| ANB | .290 ** | -.299 ** | .224 * | -.226 * | .134 | -.016 | -.237 * | -.243 * | .232 * | -.328 * |
| WITTS | .048 | -.230 | -.166 | -.046 | .076 | -.027 | -.126 | -.299 ** | .353 ** | -.283 ** |
| FA | .349 ** | .625 ** | .175 | -.112 | -.043 | -.087 | .301 ** | .203 | -.034 | .490 ** |
| A-NP | .288 ** | .239 * | -.047 | .093 | .335 ** | .106 | .027 | .057 | .079 | .183 |
| Pog-NP | .077 | .301 ** | .125 | .224 * | .170 | .099 | .206 | .214 * | -.035 | .425 ** |
| SN-PP | -.269 * | -.485 ** | .095 | -.240 * | -.180 | -.259 * | -.167 | .132 | -.075 | .015 |
| SN-OP | -.370 ** | -.586 ** | -.065 | -.208 | -.149 | -.163 | -.394 ** | .248 * | -.202 | -.135 |
| SN-MP | .056 | -.230 * | -.112 | -.086 | .017 | -.001 | -.181 | -.008 | -.203 | -.136 |
| Y-AXIS | -.1.58 | -.443 ** | -.154 | .092 | .114 | -.049 | -.217 * | .020 | -.187 | -.334 ** |

*$^{**}p \leq 0.01$, $^{*}p \leq 0.05$*

Figure 2 shows the scatter diagrams and linear regressions performed taking ANB as a measure of sagittal jaw discrepancy versus some skeletal and dental parameters. A positive linear relationship was seen with SN-OP, A-NP and LI-MP whereas negative trend was seen with NA (mm), IIA, LI-OP, LI-SN and LI-FH angles. The regression lines show that as ANB increases by $1^{o}$, SN-OP increases by $0.414^{o}$, ANP by $0.550^{o}$ and LI-MP by $0.770^{o}$, whereas LI-SN, LI-OP, LI-FH, UI-NA and IIA decrease by $0.837^{o}$, $1.436^{o}$, $1.049^{o}$, 0.368 and $1.123^{o}$ respectively.

## DISCUSSION

The role of dental compensation has been dealt within a number of studies.[11,16-18] Most of the studies were conducted on skeletal class III patterns like the ones done by Ishikawa *et al.*[11,16] This study was done to see the pattern of compensation in skeletal class II malocclusion, which is one of the most common malocclusions presenting in an orthodontic setting and a routine challenge to be managed. The compensatory dentoalveolar parameters in an attempt to compensate may reach a maximum limit value and then any treatment procedure aimed at further increasing this value will lead to a compromise in stability and aesthetics.[12]

In this study, correlation analyses between various dental and skeletal parameters showed significant associations indicating natural compensations. Correlation coefficients, however, varied considerably indicating that some parameters compensates more than the others. The study evaluated lower incisor inclination by various parameters (LI-SN, LI-OP, LI-MP and LI-FH). These parameters have shown significant differences between skeletal class I and class II. Significant associations were also found with various skeletal measurements thus showing dentoalveolar compensation in the sagittal dimension by a change in lower incisor inclination. These results confirm to those of Ishikawa *et al.*[11] who found that mandibular incisor inclination is strongly regulated by the sagittal jaw relationship. This study showed insignificant correlations for upper incisor inclination except when UI-SN is correlated with SNA. This indicates biologically insufficient dentoalveolar compensation by upper incisors in class II skeletal pattern especially when skeletal discrepancy is in the mandible. Some other studies, however, have shown compensatory changes in upper incisor inclination. Bibby found that the upper incisor inclination was significantly different between all three skeletal classes. class II having relatively retroclined upper incisors, whereas class III having relatively proclined upper incisors.[6] Also studies done by Ishikawa *et al.* reported maxillary incisor inclination to be influenced by sagittal jaw relationships.[11,17] The insufficient compensation by upper incisors in the present study sample may be a possible reason for 'upper front teeth forward' being the most common presenting complaint received in the clinical setting in class II patients.

Compensatory inclination of occlusal plane for sagittal jaw discrepancy has been statistically substantiated in this study. Linear regression showed a positive linear relationship such that for every degree increase in ANB, SN-OP increases by $0.414^{o}$. This result is consistent with the results of other studies.[11,16] Enlow *et al.* pointed out in a counterpart analysis that the cant of occlusal plane compensates for skeletal discrepancies between jaws trying to attain a class I relationship.[7]

In this study, SN-OP, LI-OP and LI-FH have been found to be the most likely parameters for compensation in sagittal skeletal discrepancies. The most appropriate cephalometric parameters for dental compensation are SN-UI, SN-LI and SN-OP. The results indicate that as skeletal discrepancy increases in class II malocclusion, lower incisors procline labially and occlusal plane steepens with respect to SN plane thus contributing the most towards the achievement of normal dentoalveolar relationship.[16]

Correction of a skeletal disharmony surely is an orthodontic challenge especially when we consider upper and lower incisors which try to compensate for any anteroposterior malrelationship in their basal bones. This in class II malocclusion is exhibited as protrusive mandibular incisors and less frequently as retrusive maxillary incisors.[18] In treatment planning, lower incisor position is usually used as the base around which treatment objectives are aimed.[19-21] This study has shown lower incisor proclination as a compensation for mandibular retrognathism. A delineation of the limitation, natural adaptation and normal variation in presenting malocclusion prior to the start of orthodontic treatment is a key to successful treatment.[22] In the clinical scenarios, where lower incisor position may need to be changed over a wider range to meet the clinical objectives, orthognathic surgery may be a better option.[23] A two-stage cephalometric analysis, therefore, becomes an essential step. Information of this kind guides the clinicians towards successful treatment planning and thus stable results. Thus, simply classifying a patient as skeletal class I or skeletal class II is a diagnostic over simplification and of limited value for clinical applicability. Treatment should also include the different individual variations as well as the dental and skeletal contributions for the malocclusion presentation.

The results of this study has highlighted the compensations in occlusal plane and mandibular incisor inclination in skeletal malocclusions. Comparison of all three sagittal classes is recommended for better understanding of the nature of dentoalveolar compensation in patients reporting to our clinical settings.

## CONCLUSION

The correlation and regression analyses have shown that as the sagittal jaw discrepancy worsens in class II skeletal pattern, the lower incisor inclinations as well as occlusal plane angulation show compensatory adjustments. In this study, SN-OP, LI-OP and LI-FH have been found to be the most likely dentoalveolar parameters showing compensations in class II sagittal skeletal discrepancies. The clinicians should evaluate complex pattern of skeletal and dental relationships as well as the amount of dentoalveolar compensations already occurring in the patient for the attainment of a successful orthodontic treatment.

## REFERENCES


1. Dibbets JMH. Morphological associations between the Angle classes. *Eur J Orthod* 1996; **18**:111-8.
2. Pancherz H, Zieber K, Hoyer B. Cephalometric characteristics of class II division 1 and class II division 2 malocclusions. A comparative study in children. *Angle Orthod* 1997; **67**:111-20.
3. Baik CY, Ververidou M. A new approach of assessing sagittal discrepancies: the beta angle. *Am J Orthod Dentofacial Orthop* 2004; **126**:100-5.
4. Solow B. The dentoalveolar compensatory mechanism: background and clinical implications. *Br J Orthod* 1980; **7**:145-61.
5. Normal variations in facial form and the anatomic basis for malocclusion. In: Enlow DH, Hans MG, (edi). Essentials of facial growth. 4th ed. Philadelphia: *WB Saunders* 1996: 214.
6. Bibby RE. Incisor relationships in different skeletofacial patterns. *Angle Orthod* 1980; **50**:41-4.
7. Enlow DH, Kuroda T, Lewis AB. The morphological and morphogenetic basis for craniofacial form and pattern. *Angle Orthod* 1971; **41**:161-88.
8. Enlow DH, Kuroda T, Lewis AB. Intrinsic craniofacial compensations. *Angle Orthod* 1971; **41**: 271-85.
9. Perera PSG. Rotational growth and incisor compensation. *Angle Orthod* 1987; **57**: 39-49.
10. Sarhan OA. Rotational effect of SN on dentoskeletal pattern within range of normal. *Angle Orthod* 1986; **59**:43-9.
11. Ishikawa H, Nakamura S, Iwasaki H, Kitazawa S, Tsukada H, Chu S. Dentoalveolar compensation in negative overjet cases. *Angle Orthod* 2000; **70**:145-8.
12. Steiner CC. Cephalometrics in clinical practice. *Angle Orthod* 1956:**29**:1-7.
13. Swlerenga D, Oesterle LJ, Massersmith ML. Cephalometric values for adult Mexican-American. *Am J Orthod Dentofacial Orthop* 1994; **106**:146-55.
14. Jacobson A. Application of the "Wits" appraisal. *Am J Orthod* 1976; **70**:179-89.
15. Ceylan I, Yavuz I, Arslan F. The effects of overjet on dentoalveolar compensation. *Eur J Orthod* 2003; **25**: 325-30.

16. Ishikawa H, Nakamura S, Iwasaki H, Kitazawa S, Tsukada H, Sato Y. Dentoalveolar compensation related to variations in sagittal jaw relationships. *Angle Orthod* 1999; **69**: 534-8.
17. Kuitert R, Beckmann S, Loenen MV, Tuinzing B. Dentoalveolar compensation in subjects with vertical skeletal dysplasia. *Am J Orthod Dentofacial Orthop* 2006; **129**:649-57.
18. Spalding P. Treatment of class II malocclusions. In. Bishara SE, (edi). Textbook of orthodontics. Philadelphia: *Saunders* 2001: 329.
19. Hasund A, Böe OE. Floating norms as guidance for the position of the lower incisors. *Angle Orthod* 1980; **50**:165-8.
20. Ismail C, Bülent B, Bölükbasi B, Longitudinal cephalometric changes in incisor position, overjet, and overbite between 10 and 14 years of age. *Angle Orthod* 2002; **72**:246-50.
21. Ellis E, Mcnamara JA. Cephalometric evaluation of incisor position. *Angle Orthod* 1986; **56**:324-44.
22. Casko JS, Shepherd WB. Dental and skeletal variation within the range of normal. *Angle Orthod* 1984; **54**:5-17.
23. Handelman CS. The anterior alveolus: its importance in limiting orthodontic treatment and its influence on the occurrence of iatrogenic sequelae. *Angle Orthod* 1996; **66**:95-109.

.....✯.....